Oct. 8, 1968 B. R. WALSH 3,404,844

OIL BURNER COMBUSTION HEAD

Filed June 9, 1966 2 Sheets-Sheet 1

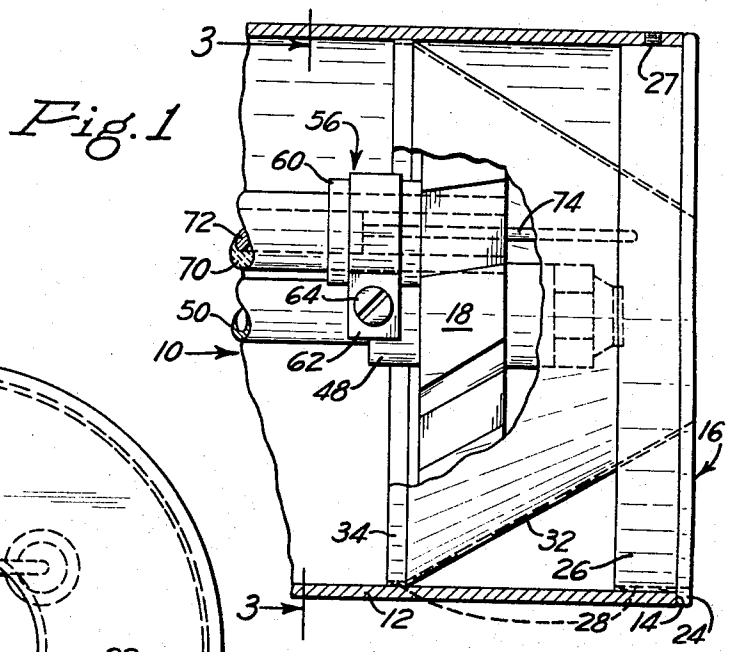


Fig. 1

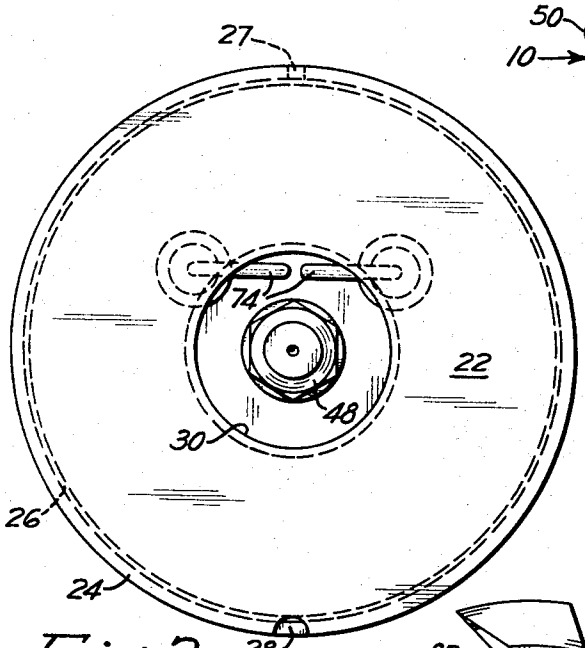


Fig. 2

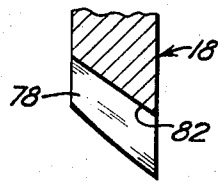


Fig. 6

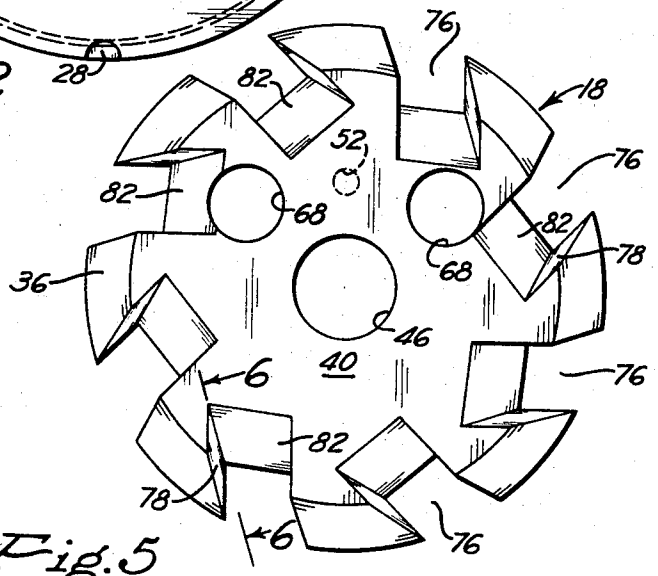


Fig. 5

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OIL BURNER COMBUSTION HEAD

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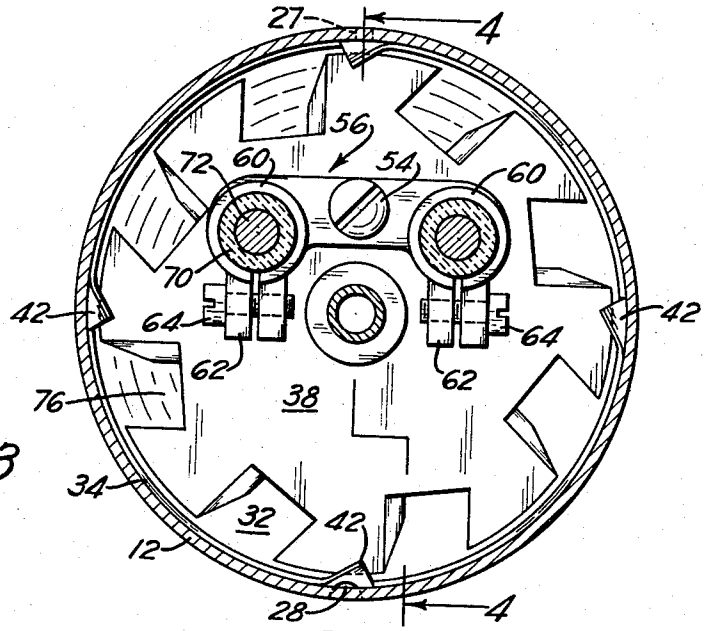


Fig. 3

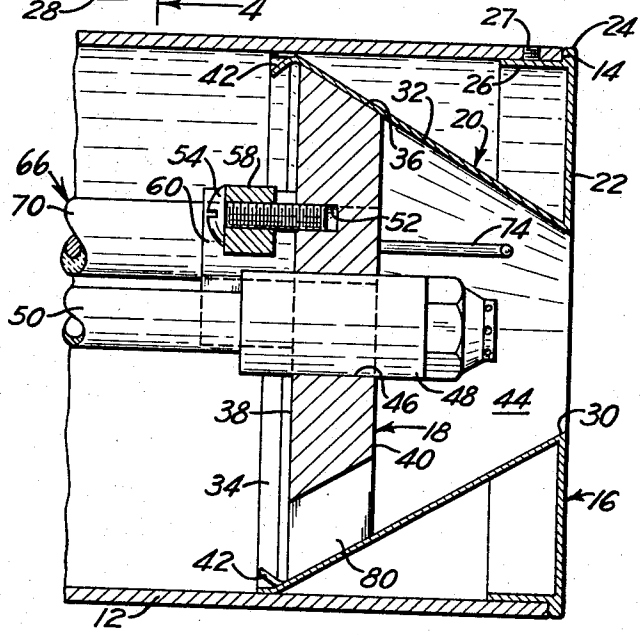


Fig. 4

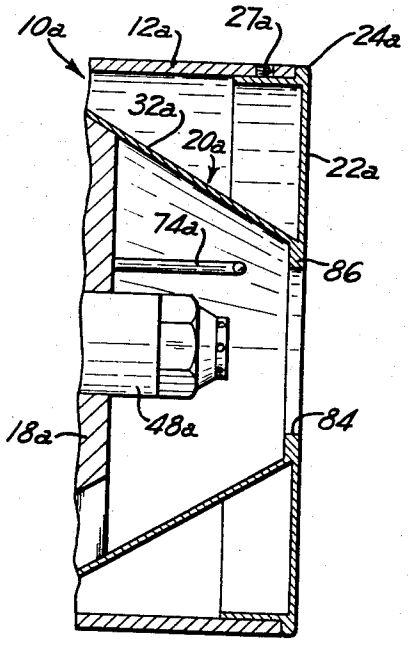


Fig. 7

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OIL BURNER COMBUSTION HEAD

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11 Claims. (Cl. 239—406)

ABSTRACT OF THE DISCLOSURE

A combustion head, particularly for gun-type oil burners, adapted to be readily installed or removed from the front end of the blast tube, having a forwardly converging cone portion terminating in an exit orifice, and a peripherally slotted swirl plate which tightly fits in the rear end of the cone portion. A swirl chamber is defined between the front surface of the swirl plate and the orifice, in which a fuel nozzle may be positioned.

This invention relates to oil burner combustion head apparatus, and more particularly to such an apparatus for use with conventional and existing gun-type oil burners.

An object of this invention is to provide an apparatus of the character described wherein a swirl plate, and a support member are preassembled into a subassembly which may be simply and easily removed from or inserted into the open front end of an oil burner air blast tube without the use of any special tools, and without the need for any special skill.

Another object of this invention is to provide an apparatus of the character described wherein the flame produced from the combustion head is short and compact, whereby the apparatus is particularly suitable for use in conversions, that is, converting furnaces, which may have been built to burn other fuels and which may have relatively small fireboxes, or, in effect, no fireboxes, to burn oil.

Still another object of this invention is to provide an apparatus of the character described comprising an air swirl plate provided with a plurality of tangential swirl slots around the periphery thereof, which slots are inclined inwardly towards and at an angle to the oil burner air blast tube axis. The outer peripheral surfaces of the lands between said slots describing a truncated cone having an imaginary apex located forwardly of the apparatus on or closely adjacent to the air blast tube axis, that is, in the oil-air mist produced by the apparatus. Said apparatus further comprising means including a mating conical surface in contact with the peripheral surfaces of said lands, whereby the air in the blast tube entering said slots has its flow changed from a direction parallel to the air blast tube axis to directions defined by said mating conical surface and the inclination of the slots, simultaneously. Upon exiting from said slots, the air, due to its own centrifugal force caused by its swirling motion, is compressed against said mating conical surface forwardly of the swirl plate and moves to the orifice of the combustion head, at which time the speed of swirl has been increased due to the progressively decreasing diameter of said mating conical surface. The nozzle is positioned so that the oil spray is drawn into the swirling air before it exits through the orifice to thereby cause thorough mixing of the oil and air.

Still another object of this invention is to provide an apparatus of the character described wherein the above advantage of thorough mixing of oil and air is achieved both when firing the burner into a furnace combustion chamber, and when firing the burner without such a chamber.

Yet another object of this invention is to provide an apparatus of the character described comprising sharp edged orifice means at the front end of the mating conical surface, forwardly of the nozzle, whereby the swirling air is forced into a vena contracta, which is formed forwardly of the nozzle, to cause more intimate intermixing between the air and the oil droplets or mist issuing from the nozzle. After passing through the vena contracta, the air forms itself in a diverging cone, and this cone may approximate the shape of the diverging cone of oil mist or droplets coming from the nozzle, whereby the oil droplets are constantly surrounded with the air required for complete burning.

The above and other objects and advantages of the present invention will in part become apparent and will in part be pointed out in the following detailed description, reference being had to the accompanying drawing forming a part thereof in which:

FIG. 1 is a side elevational view of the front end of an oil burner air blast tube having a combustion head embodying the invention mounted therein, with some parts broken away and in cross-section;

FIG. 2 is a front elevational view thereof;

FIG. 3 is a cross-sectional view taken on line **3—3** of FIG. 1;

FIG. 4 is a cross-sectional view taken on line **4—4** of FIG. 3;

FIG. 5 is a front elevational view of the swirl plate;

FIG. 6 is a partial cross-sectional view taken on line **6—6** of FIG. 5; and

FIG. 7 is a view similar to FIG. 4 showing another construction.

Referring now in detail to the drawing, **10** designates an apparatus embodying the invention. Apparatus **10** comprises an air blast tube **12** of conventional construction in gun-type oil burners. Tube **12** is open at its front end and comprises a front annular surface **14**.

Removably mounted in the front open end of air blast tube **12** is a combustion head assembly **16** comprising the invention. Assembly **16** consists of a swirl plate **18** and a support member **20**. Thus, the entire combustion head can be easily removed from or assembled into new or existing gun-type oil burners, which permits easy conversions or servicing. Support member **20** may be fabricated as a one-piece sheet metal weldment as shown, or in two parts, a front plate and a cone, or in any other suitable manner. Support member **20** comprises a front plate portion **22**, having an outer peripheral bead **24** which bears against annular surface **14** of air blast tube **12**. Extending axially rearwardly from the junction of plate portion **22** and bead **24** is an axial flange portion **26** which is in close fitting contact with the front inside surface of tube **12**. Means are provided to removably secure assembly **16** within the front open end of tube **12**, and may conveniently comprise a set screw **27** threadly mounted in a suitable threaded opening in tube **12** to bear against flange portion **26**. Bead **24** and flange portion **26** are notched out as at **28** to provide an oil drain. As is well known in this art, the blast tubes of gun-type oil burners are tilted or canted slightly forwardly and downwardly, an angle of 3° is common, for purposes of safety, so that any raw unburned oil will drain out of the front end of the tube, and not collect therein, which would create a fire or explosion hazard.

Plate portion **22** is formed with a central opening **30**. As is well known in this art, the heat output capacity of the burner is determined by the oil output capacity of the nozzle, and the air output of the blower, not shown, in combination with the diameter of opening **30**. It is within the scope of the invention that the combustion head can be used with a wide range of sizes of burners and nozzle capacities, the physical dimensions of the parts being adjusted accordingly.

Extending rearwardly and radially outwardly from the edge of front plate portion **22** at opening **30** is a truncated cone portion **32**. Extending axially rearwardly from the rear end of cone portion **32** is an axial flange portion **34**, having an outer diameter substantially equal to the inside diameter of tube **12** so as to fit snugly therein, and also substantially equal to the largest diameter of cone portion **32**.

Swirl plate **18** seats in the largest diameter of cone portion **32** adjacent to and forwardly of axial flange portion **34**. Plate **18** comprises an outer peripheral conical surface **36** which is substantially the same shape as the inside surface of cone **32**. Plate **18** is flat, disposed substantially perpendicular to the axes of tube **12** and support member **20**, and comprises a rear surface **38** and a front surface **40**. The thickness of the plate is the shortest distance between said front and rear surfaces, and is substantially less than the axial length of cone portion **32**. Means are provided to hold plate **18** wedged in against the rear portion of cone **32**, and may comprise small knock-outs **42** in flange portion **34** as shown, swagged portions, or any other suitable means. As shown in FIG. 3, the position of notch **28** coincides with one of the knock-outs **42** and passes therethrough, but the notch **28** could be positioned between two knock-outs **42**.

The space between front surface **40** and front opening **30**, and bounded by the front part of cone portion **32**, defines a swirl and mixing chamber **44**, the operation of which will be described more in detail below.

Means are provided to introduce oil in the form of droplets or a mist into chamber **44**. To this end, a nozzle could be positioned in the chamber by struts, with the supply pipe passing through cone **32**, or the oil could be introduced in any other suitable manner. Also, the oil could be added at a place other than the chamber **44**, i.e., the assembly **16** could be used with one fluid or a mixture. However, in the embodiment shown, plate **18** is formed with a central through opening **46** which receives a nozzle **48** which is mounted on the front end of an oil supply pipe **50** disposed axially in tube **12**. As is conventional in this art, pipe **50** is also supported in the conventional manner at its rear end at the rear end of the burner. Nozzle **48** may be of any conventional design.

Means are provided to ignite the air-oil mist, and to provide a safety against a flame-out. To this end, a blind threaded opening **52**, which receive a mounted screw **54**, extends forwardly into plate **18** from rear surface **38**. Mounted between the head of screw **54** and rear surface **38** is an electrode supporting yoke **56**. Yoke **56** comprises a central web portion **58** and a pair of split electrode supporting collars **60** each provided with a pair of legs **62** and a tightening screw **64**. An electrode **66** passes through each collar **60** and a registering opening **68** in plate **18**. Each electrode **66** comprises an outer hollow cylindrical casing **70** of porcelain or other suitable electrical insulating material, inside of which is a conductor core **72**, provided with an arc terminal **74** at its front end. The front ends of terminals **74** are in a predetermined spaced relation to each other slightly forwardly of the front end of the nozzle **48**. Means not shown are provided to create an electrical arc across terminals **74** to ignite the air-oil mist produced by the apparatus, and other means are provided to protect against flame-out, in the usual manner. Any other suitable means, such as igniters mounted on the outside of the blast tube, can be used in place of the above structure, but the structure described is preferred because it makes a compact burner.

Swirl plate **18** is formed with a plurality of tangential swirl slots **76** extending inwardly from outer conical surface **36**. The axes of slots **76** are inclined inwardly and forwardly towards and at an angle to the axis of tube **12**, so that the air passing through said slots will swirl or spin through chamber **44** as it moves towards opening **30**. In the drawing, plate **18** has eight slots **76**, however, it will be understood that either more or fewer slots can be provided depending upon the particular application of the apparatus, as will be evident to those skilled in this art.

Each slot **76** functions in a way similar to a nozzle in that the slot, in combination with the adjacent portion of cone **32**, forms an air passage closed on four sides which decreases in cross-sectional area from rear surface **38** towards front surface **40**. Each such passage is defined by a short flat side wall **78** (see FIG. 6), a long flat side wall **80**, (see lower portion of FIG. 4), a flat bottom wall **82** interconnecting the inner ends of side walls **78** and **80**, and the portion of cone **32** opposite the bottom wall. The short and long side walls **78** and **80** are generated because the axis of the passage, defined by but spaced from the center line of bottom wall **82**, is at an angle to the axis of the blast tube.

In operation the burner includes a conventional air blower means (not shown) to blow air through the blast tube until it impinges upon rear surface **38** of the swirl plate **18**. If necessary or desired, air deflector means such as a plate or the like, not shown, can be mounted on oil pipe **50** rearwardly of the swirl plate.

All of the air coming through the tube is directed through these passages. The air in the tube is not disrupted from its parallel, laminar flow until it reaches the swirl plate, and at that time it is simultaneously changed to a flow which is both spinning and conical, converging towards opening **30**. This is an advantage over prior apparatuses which have two separate means spaced from each other in the blast tube to impart first spin and then conical flow or vice versa, since the flow component imparted by the first means is somewhat dissipated by the time the air reaches the second means to have the second component imparted to it. The passages, acting somewhat like nozzles, simultaneously impart additional speed to the air, and cause it to swirl because of their inclination to the axis of the blast tube, and create a blanket of air swirling against the inside surface of cone portion **32** within chamber **44**. The centrifugal force of the air in combination with the decreasing cross-sectional area of chamber **44** still further increases the speed of the blanket of air causing it to compress itself even more against cone **32**. A semi-evacuated or low-pressure zone is created by said swirling blanket of air within chamber **44** because the spinning blanket of air tends to draw the air in its vortex or center region into itself. When the swirling blanket of air reaches positions on the cone forwardly of the front end of the nozzle **48**, it will tend to draw the oil mist produced from the nozzle into itself because of the aforesaid semi-vacuum condition, thus causing improved atomization or particulation of the oil hence causing intimate intermingling of the oil and the air, to result in efficient burning of the oil.

When the air blanket and oil mist reaches orifice **30**, the centrifugal force will tend to throw the air-oil mist outwardly thus creating a compact, short flame. This short flame is advantageous particularly in conversion applications, that is, when using the apparatus of the present invention to convert a furnace which was designed for some other fuel to burn oil, which furnace may have a small firebox, or, in certain applications, no effective firebox.

In FIG. 7 is shown a modified construction **10*a*** in which parts similar to corresponding parts in the first embodiment are indicated by the same reference number followed by "*a*." In place of orifice **30**, support member **20*a*** comprises an orifice **84** which is defined by a sharp-edged annular flange **86** extending inwardly from the junction of cone portion **32*a*** and front wall portion **22*a***.

In operation, the swirling or spinning blanket of air moving forwardly on the inside surface of cone portion **32*a*** will be interrupted by flange **86** which is positioned in its path of exit from the cone, and in forwardly spaced relation to the nozzle. Flange **86** will thus force the air-oil mist into a vena contracta before it exits from the

apparatus. This vena contracta will cause thorough intermixing of the air and oil particles. The sharp-edged orifice construction of FIG. 7 is particularly useful in certain applications such as where a nozzle having a relatively narrow included spray angle is used. In all other aspects, the construction of FIGS. 1 to 6 is considered substantially equivalent to the construction of FIG. 7, and both constructions are equally preferred at present.

While the invention has been described in some detail above, this description is to be considered exemplary only, and it is to be understood that the protection granted is to be limited only within the spirit of the invention and the scope of the following claims.

I claim:

1. In a combustion head, the combination comprising a two-part assembly comprising a support member and a swirl plate, said support member comprising a front plate portion formed with a central orifice, swirl chamber forming means comprising a cone portion of said support member having its smallest diameter front end joined to said plate portion at said orifice, and means on said support member at the rear end of said cone portion to removably hold said swirl plate wedged against the rearmost portion of said cone portion, whereby said two-part combustion head assembly may be mounted into and dismounted from the air blast tube of an oil burner from the front open end of said air blast tube.

2. The combination of claim **1**, said swirl plate having an axial length less than the axial length of said swirl chamber and being formed with a plurality of peripheral openings inclined forwardly towards and at an angle to the combustion head axis, and the portions of said swirl plate between said openings being in closely abutting relation to said cone portion, whereby each of said openings in combination with said cone portion comprises a separate passage.

3. The combination of claim **2**, each of said openings being so formed that the cross-sectional area of each of said passages decreases in planes perpendicular to said axis from rear to front of said swirl means.

4. The combination of claim **2**, an axial flange extending rearwardly from the rearmost largest diameter of said cone portion, and said swirl plate holding means comprising a plurality of spaced axially inwardly offset portions of said flange, whereby said swirl plate may be removed from said cone portion by turning said plate about said axis with respect to said cone portion until said openings are aligned with said offset portions, whereupon said plate may be moved axially rearwardly out of said cone portion.

5. The combination of claim **2**, each of said swirl plate openings being defined by a bottom flat surface disposed in spaced relation to the conical peripheral surface of said swirl plate and by a pair of flat side walls extending perpendicularly from the sides of said bottom surface to said conical peripheral surface of said swirl plate, and said bottom surface describing an angle to a plane perpendicular to said axis larger than the included angle of the cone described by said conical chamber in a plane containing the axis of said cone.

6. The combination of claim **1**, in combination with the air blast tube of an oil burner, said cone portion having a rearmost largest diameter substantially equal to the inside diameter of said blast tube, whereby the air passing through said blast tube will pass through said swirl plate and said swirl chamber.

7. The combination of claim **6**, said swirl plate being formed with a central opening, and a nozzle positioned in said opening with its front end located within said chamber in spaced relation to said orifice.

8. The combination of claim **7**, said swirl plate having an axial length less than the axial length of said swirl chamber and being formed with a plurality of peripheral openings inclined forwardly towards and at an angle to the combustion head axis, and the portions of said swirl plate between said openings being in closely abutting relation to said cone portion, whereby each of said openings in combination with said cone portion comprises a separate passage.

9. The combination of claim **8**, an axial flange portion extending rearwardly from the rearmost largest diameter of said cone portion, and said swirl plate holding means comprising a plurality of spaced axially inwardly offset portions of said flange portion, whereby said swirl plate may be removed from said cone portion by turning said plate about said axis with respect to said cone portion until said openings are aligned with said offset portions, whereupon said swirl plate may be moved axially rearwardly out of said cone portion.

10. The combination of claim **7**, an axial flange extending rearwardly from said front plate portion, said axial flange having an outside diameter substantially equal to the inside diameter of the front end of said air blast tube, an annular bead on said front plate portion in contact with the front edge of said air blast tube, and removable securing means passing through said air blast tube to contact said axial flange.

11. The combination of claim **8**, each of said swirl plate openings being defined by a bottom flat surface disposed in spaced relation to the conical peripheral surface of said swirl plate and by a pair of flat side walls extending perpendicularly from the sides of said bottom surface to said conical peripheral surface of said swirl plate, and said bottom surface describing an angle to a plane perpendicular to said axis larger than the included angle of the cone described by said conical chamber in a plane containing the axis of said cone.

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M. Y. MAR, *Assistant Examiner.*

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,404,844 December 3, 1968

Bruce R. Walsh

It is certified that error appears in the above identified patent and that said Letters Patent are hereby corrected as shown below:

The issue date of "Oct. 8, 1968", appearing in the grant, in the heading to the sheets of drawings and in the first page of the printed specification, should read -- Dec. 3, 1968 --.

Signed and sealed this 17th day of June 1969.

(SEAL)
Attest:

Edward M. Fletcher, Jr.
Attesting Officer

WILLIAM E. SCHUYLER, JR.
Commissioner of Patents